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Changes in Food Consumption Patterns in the Republic of Korea

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Diets have been changing rapidly in the Republic of Korea, where fast income growth and urbanization favor the consumption of beef, pork, chicken, and wheat flour and discourage the consumption of rice, barley, and fish. The result could be rice surpluses and higher beef prices.

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This paper — a product of the International Commodity Markets Division, International Economics Department — is part of a larger effort in PRE to understand the changes in food markets in developing countries, especially in those countries experiencing rapid income growth. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Aban Daruwala, room S7-042, extension 33713 (47 pages with figures and tables).

Urbanization and income growth explain the increasing consumption of beef, pork, chicken, and wheat flour, and the proportionate decline in the consumption of rice, barley, and fish.

Continuing urbanization and income growth should simply reinforce these trends. The same phenomenon is occurring in other rapidly growing Asian countries with similar dietary profiles.

The implications for estimating demand are important.

First, there is a declining trend in the income elasticity of rice, which became negative in the 1980s. So, rice surpluses will grow if production growth rates are not reduced.

Income elasticities of demand for beef are relatively high, so expected increases in real income will continue to put upward pressure on beef prices, unless beef import quotas are expanded more rapidly or eliminated.

Second, the relatively high own-price elasticities for meats — particularly beef and pork — imply that reduced protection for Korean meat producers would significantly increase per capita meat consumption.

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I. Introduction *

Since the mid-1970s, rapid economic growth and urbanization in the Republic of Korea have contributed to a gradual change in food consumption patterns. Demand for meat and other higher-value foods, such as dairy products, fruits and vegetables, have increased while consumption of staple cereals, such as rice and barley, have declined. Direct consumption of wheat has increased since the early 1980s, and indirect grain consumption, through livestock feeding (particularly of maize and wheat) has increased sharply. These changes in Korea presage developments in the food consumption patterns of other rapidly growing developing countries. 1/

The gradual decline in per capita rice consumption has become a concern to the Korean government as stocks of rice have increased significantly in recent years. To eliminate the rice surplus, the government has introduced measures to diversify rice utilization, including providing support to food processing companies in the development of processed foods

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* Helpful comments of Ronald Duncan and Donald Mitchell are gratefully acknowledged.

1/ Although no developing country has matched Korea's sustained economic growth rate (real GNP per capita in US$ grew at 7.7% p.a. between 1980 and 1988), a number of developing countries in Asia have been growing rapidly and have approached Korea's income growth in recent years. Between 1986 and 1988, real GNP per capita (in US$) increases were recorded as follows: Thailand (8.0% p.a.), China (9.0% p.a.), Singapore (8.8% p.a.), Hongkong (9.2%). While other countries such as India, Indonesia and Malaysia registered lower growth rates, at 4.4% p.a., 1.6% p.a. and 3.3% p.a., respectively, between 1986 and 1988, they were also exhibiting diversification in the diet with increasing consumption of livestock products and wheat.

based on rice and to substitute rice for wheat flour in products such as noodles and cakes. The government has also begun to sell rice from government stocks to food processing companies at 80% of the regular price. Other measures are being considered, including raising the price of wheat flour by introducing a levy on wheat imports. If these changes in food consumption patterns are permanent, then the adoption of such policies--designed to offset the effects of incentives given for rice production--will become more costly over time.

While domestic demand for beef continues to grow, domestic beef supplies have declined in recent years and supplies of imported beef have been restricted. 2/ Consequently, domestic beef prices rose significantly. Between 1987 and 1988, retail prices of beef increased by about 75%. In mid-1988, Korea reopened its beef market to imports as domestic production failed to meet the growth in demand. More recently, Korea has agreed to liberalize its beef market as a result of negotiations under the General Agreements on Tariffs and Trade, which should serve to put downwards pressure on domestic beef prices.

This paper has two objectives. First, to present estimates of the response parameters for the demand for meats and foodgrains in the Republic of Korea. These estimates are based on time series data on per capita consumption, expenditure and prices for the period 1961-87. A system of budget share equations for Korean food consumption was estimated using alternative specifications of the Almost Ideal Demand System (AIDS). One of the specifications accounts for habit formation through a systematic change in

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2/ Beef imports were banned during the period 1984 to mid-1988.

one of the parameters. Urbanization effects were also tested by including proxy variables for the rate of urbanization such as the percentage of female labor force participation and percentage of population in urban cities.

The second objective is to use the estimated demand structure to forecast changes in food consumption patterns. Most of the income and price elasticities are seen to be changing over time. For forecasting purposes, therefore, elasticities estimated at the sample means will not be suitable. A useful means for deriving elasticities for forecasting purposes is to project the trends in the elasticities derived here. The systems approach to modeling food demand ensures that the estimated elasticities satisfy the general properties of consumer behavior in the forecast period as well as within the sample. The forecasts of the elasticity estimates should provide a good basis for calculating the costs and benefits of policies which would affect the production and consumption of these important foodstuffs.

II. Consumption Patterns for Meat and Foodgrain

The consumption of staple cereals has declined since the mid-1970s, while the direct and indirect consumption of other grain has increased sharply. The declines in the consumption of rice and barley and the increase in the consumption of wheat flour and meats can be seen in Table 1 and Figures 1a and 1b. The quantity of grains and oilseeds fed to livestock increased from 300,000 tons in 1970 to more than 3 million tons in 1987. Coarse grains, mostly imported, accounted for about 92% of feed use in 1987 (Figure 2a). As a result of these changes, imports of wheat, maize and soybeans have increased consistently (Figure 2b).

Table 1: Republic of Korea: Per Capita Consumption of Meats, Marine Products, and Foodgrains, and Per Capita GNP, 1965-87.

Year	Meats and Marine Products					Foodgrains			Total Foodgrains	GNP Per Capita ('000 Won, in 1980 prices)
	Beef 1/	Pork	Chicken	Total Meat	Marine Products	Rice	Wheat	Barley		
1965	0.95	2.0	0.5	3.4	20.6	120.4	14.0	49.7	184.1	225.8
1966	1.01	3.3	0.6	4.9	21.6	123.6	12.1	52.5	188.2	251.8
1967	1.06	2.4	0.8	4.3	22.7	127.9	20.8	59.4	208.1	281.0
1968	1.16	2.0	1.1	4.3	25.2	119.0	19.4	56.5	194.9	317.6
1969	1.05	2.4	1.3	4.7	23.8	122.7	24.8	56.5	204.0	356.0
1970	1.20	2.6	1.4	5.2	24.0	136.7	25.8	47.5	210.0	373.9
1971	1.20	2.5	1.5	5.2	27.0	124.3	32.9	51.0	208.2	396.8
1972	1.20	2.7	1.6	5.5	32.5	126.2	30.1	52.2	208.5	427.0
1973	1.30	2.6	1.5	5.4	38.9	122.2	36.2	51.9	210.3	531.0
1974	1.50	2.7	1.5	5.7	47.3	134.8	26.1	51.9	212.8	584.5
1975	2.00	2.8	1.6	6.4	44.3	129.0	31.1	53.3	213.4	615.0
1976	2.10	3.0	1.7	6.8	45.9	129.9	32.5	50.9	213.3	710.2
1977	2.20	3.9	2.0	8.1	45.7	141.4	33.1	42.5	217.0	813.6
1978	3.10	4.8	2.2	10.1	46.3	141.0	28.5	30.9	200.4	943.7
1979	3.00	6.0	2.4	11.4	45.0	133.4	29.2	34.8	197.4	997.4
1980	2.60	6.3	2.4	11.3	46.0	149.1	30.8	37.5	217.4	900.0
1981	2.40	5.4	2.3	10.1	55.0	143.5	31.4	31.0	205.9	902.7
1982	2.70	6.0	2.5	11.2	50.4	146.6	29.8	22.5	198.9	1,012.3
1983	2.90	7.4	3.0	13.3	54.1	145.5	26.7	17.7	189.9	1,087.7
1984	2.60	8.4	2.9	13.9	55.0	144.0	30.9	20.4	195.3	1,197.7
1985	2.90	8.4	3.1	14.4	59.3	139.4	30.8	17.9	188.1	1,234.6
1986	3.50	8.2	3.3	15.0	60.1	137.3	35.1	17.5	189.9	1,448.0
1987	3.60	8.9	3.5	16.0	60.1	128.9	42.5	16.5	187.9	1,492.0

1/ Boneless basis.

Source: Korea Statistical Yearbook, Bank of Korea (various years).

Figure 1a

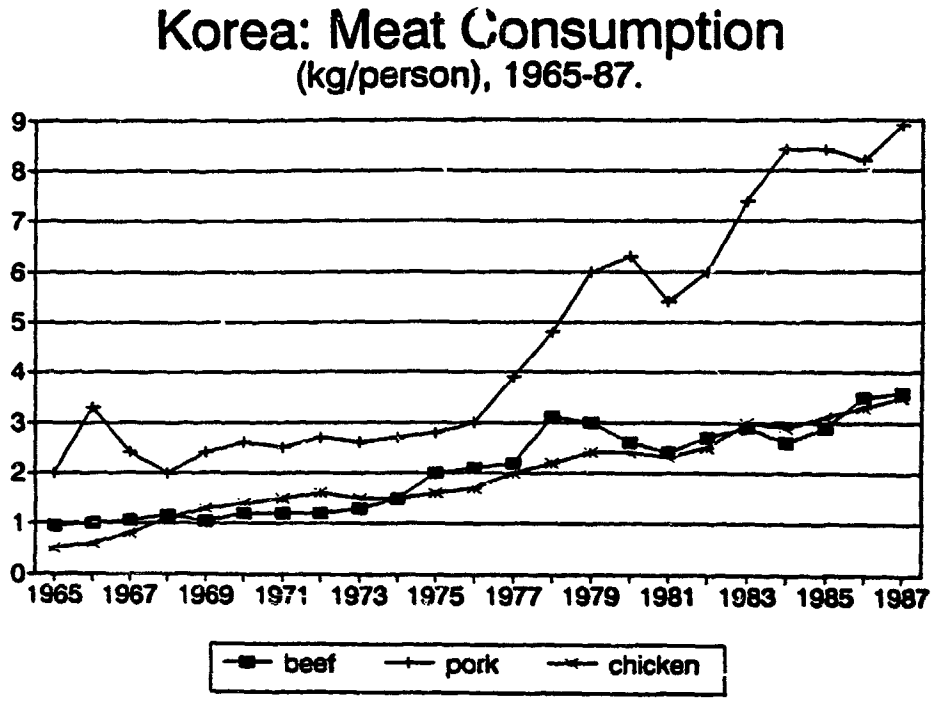


Figure 1b

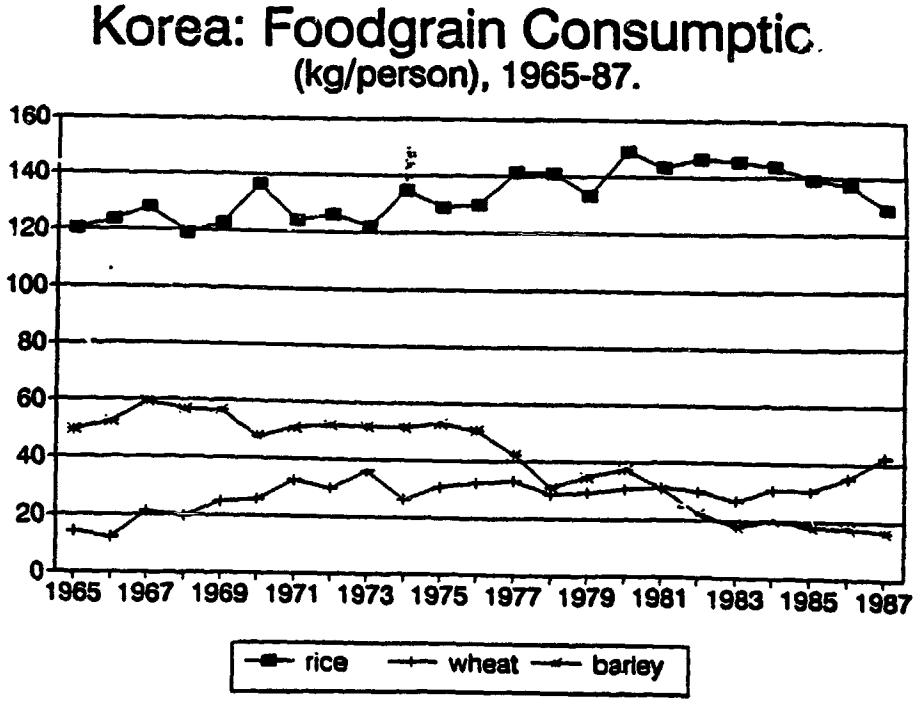


Figure 2a

Korea: Feed Use of Grains and Oilseeds
('000 tons), 1965-87.

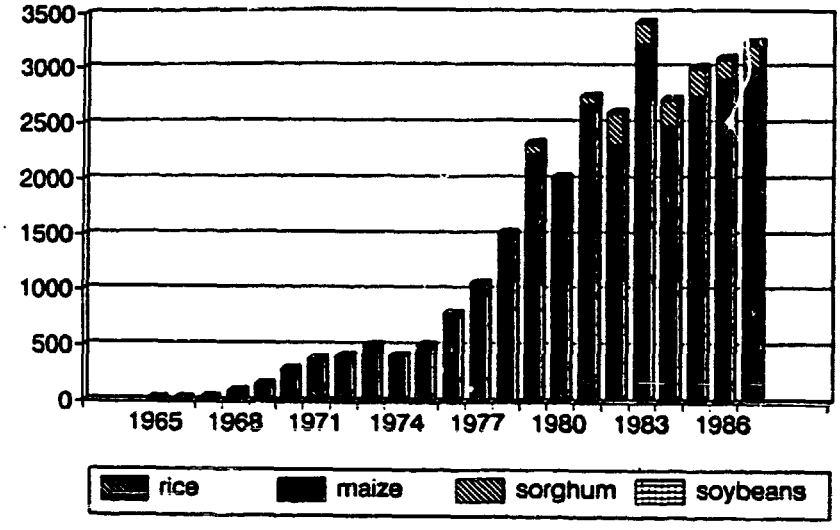
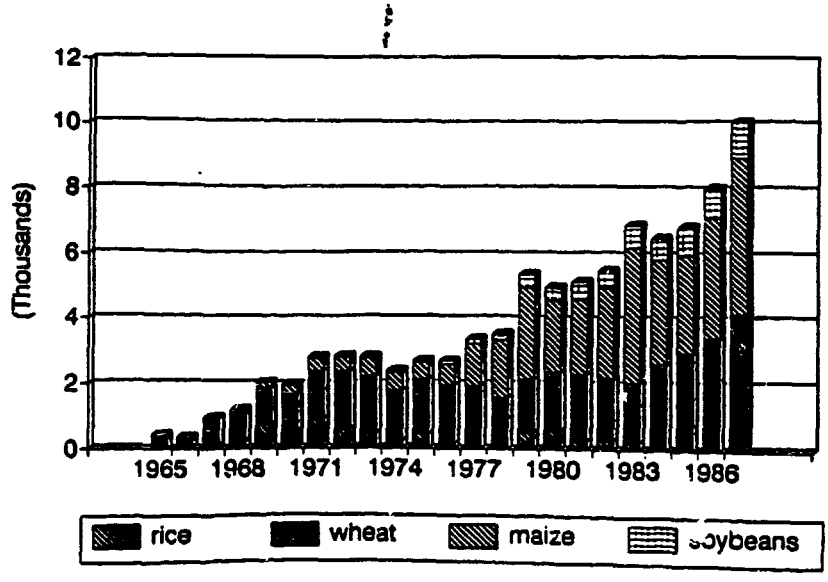


Figure 2b

Korea: Grain Imports
(tons), 1965-87.



As indicated in Table 1, marine products continue to be the major source of protein for Korean consumers, with 60 kg per person consumed in 1987. However, since 1965 per capita meat consumption has increased almost five-fold, from 3.45 kg to 16 kg. Of the meats, chicken and pork consumption grew most rapidly at 7.3% and 7.2% p.a., respectively, followed by beef at 6.4% p.a. Chicken consumption has grown steadily over this period; however, per capita pork consumption has grown rapidly only since 1976.

The consumption of starchy foods has fallen over the last two decades. Per capita consumption of foodgrains (including rice, wheat and barley) fell from 210 kg in 1973 to 188 kg in 1987. The decline in rice consumption in the 1960s through the early 1970s is partly explained by government policy. In the 1960s, the Korean government restricted rice consumption and encouraged consumption of wheat flour and barley by requiring restaurants to mix at least 20% barley in cooked rice, and prohibited the use of rice in producing alcohol. In 1969, the government designated Wednesdays and Saturdays as "Days of Wheat Flour," when restaurants were required to serve only foods made from wheat flour. These measures continued until the mid-1970s when Korea achieved self-sufficiency in rice, mainly due to increases in production from high-yielding varieties. 1/

The recent decline in rice consumption could be explained by several factors. First, rice has been partly replaced in the Korean diets as consumers with rising incomes diversify their consumption to include more

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1/ In 1976, the government restrictions on rice consumption and alcohol production were lifted and the "Days of Wheat Flour" were abolished.

meats, dairy products, fruits, vegetables and wheat flour. Second, wheat flour is cheaper. Third, products made from wheat flour, such as breads, may be more suited than rice products to the changed lifestyle, with a larger proportion of people living and working in cities and higher female participation in the urban workforce. These various hypotheses will be examined by means of the demand model set out below.

Several factors may have contributed to the rapid expansion in meat consumption in the Republic of Korea. First, real per capita GNP (in 1980 prices in Won) increased at an annual rate of about 8.5% p.a. between 1965 and 1987. Second, there has been a relatively high rate of population growth and migration of labor from rural to urban areas as the country has industrialized. (The population growth rate has declined sharply, however, from about 2.6% p.a. in the mid-1960s to about 1.5% p.a. recently.)

The role of prices also must be considered. Figure 3 shows the real prices of meats and cereal products during 1965-87. Real meat prices increased for most of this period but then rapidly declined, starting first with chicken prices in 1979 and lastly with beef prices which have declined since 1984. Obviously, other factors have more than offset the increase in meat prices. While wheat flour prices generally fell over the 1965-87 period, the sharp rise in real rice prices over this period reflects the growth in protection to this industry. The increase in real beef prices for most of the period also reflects protection of the beef sector.

Figure 3


Korea: Retail Meat Prices
(1980 Prices, Won/Kg)
4500
4000
3500
3000
2500
2000
1500
1000
500
1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987
Beef
Pork
Chicken

III. Food Demand Model

The development of duality theory and flexible functional forms allows several approaches to modeling consumer demand in a systems framework (Deaton and Muellbauer (1980), Johnson, Hassan and Green (1984)). The Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer is used here to model the demand for meat and foodgrains in Korea. This model combines the best of the theoretical features of both the translog and Rotterdam models. The AIDS model provides a first-order approximation to any arbitrarily chosen demand system, satisfies the axioms of choice exactly, and under certain conditions, allows perfect aggregation across consumers. Although the AIDS model does not implicitly impose the theoretical restrictions of homogeneity, Slutsky symmetry, and adding-up, these restrictions can be imposed and tested easily.

In this demand system, consumers' preferences are represented by the following expenditure or cost function:

$$(1) \quad \ln m(U,p) = \alpha_o + \sum_k \alpha_k \ln p_k + \tfrac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k + U \beta_o \pi\pi_k p_k^{\beta_k}$$

where m is the expenditure required to achieve utility level U at price p_k ($k = 1,\ldots n$). α_i, β_i and γ_{ij} are parameters to be estimated.

Using the Hotelling-Shepard lemma, the demand equations in budget share form are:

$$(2)\quad w_i(P,Y) = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i (\log Y - \alpha_o - \sum_k a_k \log p_k - \tfrac{1}{2} \sum_k \sum_j \gamma_{kj}^{*} \log p_k \log p_j)$$

or alternatively,

$$(3)\quad w_i = \alpha_i + \Sigma_j \gamma_{ij} \ln p_j + \beta_i \ln Y/P$$

where

$$(4)\quad \ln P = \alpha_o + \sum_k \alpha_k \ln p_k + \tfrac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j$$

and

p_{jk} = price of goods j and k

Y = per capita total expenditure (income) 3/

The AIDS model has several advantages for analyzing the demand for food in developing countries. First, unlike other demand systems, such as the Linear Expenditure System (LES), the AIDS system is flexible enough to closely approximate demand elasticities at particular data points. Also, the possibility of inferior commodities is allowed.

3/ Separability is not assumed in the specification. Prices of other commodities are incorporated by deflating meat and foodgrain prices using the consumer price index for all goods.

Habit formation is tested using the specification of Manser (1976) which states that any utility function can be extended to allow for habit formation by specifying that certain of the parameters depend on past consumption. We assume, therefore, that the α_i parameter (average budget share) depends linearly on previous consumption levels as follows:

$$(5) \quad \alpha_i = a_i + d_i q_{it-1}$$

where d_i is the habit parameter and q_{it-1} is the quantity of the ith commodity consumed in the previous period. Hence, with the habit variable the average budget share is no longer a constant but varies over time.

The adding up restriction becomes:

$$(6) \quad \sum_i a_i = 1.0; \quad \sum_i d_i = 0; \quad \sum_i \gamma_{ij} = 0; \quad \text{and} \quad \sum_i \beta_i = 0$$

The AIDS model with habit formation is written as:

$$(7) \quad W_i = a_i + d_i q_{it-1} + \sum_j \gamma_{ij} \log P_j + \beta_i \log (Y/P)$$

The effects of urbanization on food demand are tested by including proxy variables such as the percent of total population in urban cities and the percent of female labor force participation.

IV. Data and the Estimation Procedure

The data needed to estimate the parameters for the commodity budget share equations include per capita expenditures, prices and per capita food consumption. The commodities considered are beef, pork, chicken, fish, rice, wheat, barley and other foods. The data come from several sources. Retail prices are from the Monthly Review published by the National Agricultural Cooperative Federation (NACF). Price indices are from the Annual Report on the Price Survey and data on total expenditures are from the Annual Report on the Family Income and Expenditure Survey, both published by the National Bureau of Statistics, Economic Planning Board. Annual time series data from 1961 to 1987 are used in the analysis.

In the estimation the sum of the budget shares, w_i, is constrained to unity. To estimate the parameters of the budget share equations, additive disturbances are postulated. The disturbances are assumed to have a multivariate normal distribution with mean zero and a constant covariance matrix. Since the budget shares sum to one and the disturbances must sum to zero across commodities for each observation, the covariance matrix for the original disturbances is singular. Hence, the budget share equation for "other foods" is arbitrarily deleted and the non-linear Zellner estimation procedure is applied to the remaining budget share equations. The iterative Zellner estimation is invariant to which budget share equation is deleted and asymptotically equivalent to the maximum likelihood estimation.

The monotonicity condition is equivalent to requiring budget share equations to be non-negative. The quasi-convexity condition is equivalent to requiring the nXn matrix of Slutsky price derivatives to be negative semi-

definite. Neither of these conditions is imposed directly in estimation, but they are verified by checking the estimated parameters at selected data points.

V. Results of Demand System Estimation

In order to correspond to well-defined consumer preferences, the estimated demand functions must satisfy certain regularity conditions. However, since the AIDS utility function does not satisfy the regularity conditions globally, local properties were checked at several data points. Homogeneity was originally imposed in the estimation. Neoclassical utility theory requires that the indirect utility be non-increasing in normalized prices. This requirement is equivalent to the non-negativity of all predicted budget shares. This monotonicity requirement is satisfied at all data points. Theory also requires that the indirect utility function be quasi-convex in normalized prices. The local quasi-convexity of the indirect utility function was checked by computing eigen-values of the matrix of Hessian or elasticities of substitution. Since the matrix of the elasticities of substitution is singular, one eigen-value must be zero and the rest must be non-positive. Convexity was found to be satisfied for the demand system.

The estimates of the parameters of the demand system without habit formation and without incorporating any constraints on the parameters are presented in Table 2. The column headed $\Sigma\gamma_{ij}$ is the row sum of the unconstrained γ_{ij} matrix, i.e., the sum of the own- and cross-price effects from the original OLS regression. Under homogeneity, this term should be zero. The t-statistics presented in parenthesis beneath the $\Sigma\gamma_{ij}$ term are the square roots of the F-ratios, obtained by comparing the sum of the squared

Table 2: Parameter Estimates and Tests of Homogeneity 1/

Commodity	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	$\sum\gamma_{ij}$	R^2	DW
Beef	-0.153	-0.015	-0.0098	0.0033	0.0035	-0.0059	.0035	0.0083	0.003	0.91	1.47
	(-4.67)	(1.28)	(-2.68)	(0.81)	(0.88)	(-0.88)	(1.09)	(2.16)	(1.2)		
Pork	-0.021	-0.009	0.0035	-0.0042	0.002	0.003	0.0056	0.014	0.024	0.86	1.97
Chicken	-0.0035	-0.0016	0.0027	.0003	-.0043	-0.0001	-0.0030	-0.001	-0.005	0.80	1.4
	(-0.35)	(-0.93)	(2.49)	(0.27)	(3.57)	(-0.45)	(-3.07)	(-0.95)	(-1.52)		
Rice	0.793	-0.1398	-0.012	-0.0113	0.0119	-0.155	0.0198	0.045	0.038	0.95	2.1
	(6.51)	(-6.6)	(-0.89)	(-0.74)	(0.81)	(-6.15)	(1.63)	(3.16)	(0.43)		
Wheat	0.095	-0.006	-0.002	0.0073	-0.002	0.0025	0.0008	-0.009	0.002	0.90	2.6
	(2.99)	(-1.10)	(-0.67)	(1.83)	(-0.62)	(0.38)	(0.25)	(-2.4)	(-1.20)		
Fish	-0.026	-0.026	-0.0098	-.0005	-0.001	-0.0094	0.010	0.0219	0.011	0.98	1.6
	(-3.68)	(-3.68)	(-2.13)	(-0.11)	(-0.23)	(-1.1)	(2.42)	(4.51)	(-0.8)		

Note: t-statistics for estimated coefficients are shown in parentheses.

γ_{i1} ... γ_{i7} are the coefficients on prices, i=1,2,3,4,5,6,7; 1=beef, 2=pork, 3=chicken, 4=rice, 5=wheat, 6=fish, 7=barley.

β_i - is the coefficient on total expenditure

α_i - is the constant term

errors of the unconstrained OLS equation with those obtained when homogeneity was imposed. None of these t-statistics are significant, implying that homogeneity is not rejected by the data. Consequently, homogeneity was imposed on the system.

Tables 3 and 4 present the OLS parameter estimates for the demand system when homogeneity ($\Sigma_j \gamma_{ij} = 0$) is imposed, without and with habit formation, respectively. Most of the coefficients are significant. In Table 3 (without habit formation), beef is classified as a relative luxury good ($\beta > 0$) and pork, chicken, rice, wheat, barley and fish are classified as relative necessities ($\beta < 0$). These results imply that increased real per capita expenditure led to an increased budget shares for beef and decreased shares for the rest of the commodities. The budget shares are particularly responsive to changes in own prices and real per capita expenditures. Own-price elasticities are all less than one in absolute value, thus increases in their price would increase their budget share. Rice, the staple cereal, is the least responsive to changes in its own price. According to the cross-price elasticities, the rice price had the most significant influence on the budget shares.

The demand estimates with habit formation are shown in Table 4. Beef is again classified as a relative luxury good, while pork, chicken, fish, rice, wheat flour and barley are relative necessities. Most of the coefficients are significantly different from zero. The habit parameter (d_i) has a small positive effect on the budget share of all commodities except barley. Of the remainder, only the habit parameter in the budget share equations for fish is not significantly different from zero. Demand is price

Table 3: Food Demand System Estimates: Adding-Up And Homogeneity Restrictions Imposed.

Commodity	Estimated Coefficients									Summary Statistics		
	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	SSE	R^2	DW
Beef	-0.1274	0.0056	0.0072	0.0058	-0.0005	0.0133	0.0059	-0.0101	-0.0037	4.36×10^{-5}	0.93	1.43
	(-3.9)	(1.13)	(1.93)	(1.44)	(-0.13)	(-1.95)	(1.89)	(2.78)	(-1.05)			
Pork	-0.0132	-0.0096	0.0029	0.0049	-0.0028	0.0042	0.0060	0.0155	-0.0028	2.04×10^{-5}	0.87	2.0
	(-0.59)	(-2.82)	(1.14)	(1.8)	(-0.98)	(0.91)	(2.79)	(6.24)	(-1.16)			
Chicken	0.0015	-0.0023	0.0026	0.0004	0.0043	0.0002	-0.0031	-0.0006	-0.0007	5.03×10^{-6}	0.80	1.28
	(0.13)	(-1.35)	(2.05)	(0.33)	(3.01)	(0.07)	(-2.95)	(-0.52)	(-0.6)			
Rice	0.9271	-0.1458	0.0152	-0.0224	0.0087	0.1549	0.0142	0.0207	-0.0041	7.09×10^{-4}	0.96	2.17
	(7.04)	(-7.26)	(1.01)	(-1.39)	(0.52)	(5.69)	(1.13)	(1.41)	(-0.29)			
Wheat flour	0.0711	-0.0087	-0.0001	0.0052	0.0004	0.0056	-0.0004	-0.0108	0.0047	4.85×10^{-5}	0.92	2.92
	(2.15)	(-1.66)	(-0.03)	(1.23)	(0.08)	(0.78)	(-0.12)	(-2.88)	(1.26)			
Fish	0.3631	-0.0299	-0.0087	-0.0021	0.0006	-0.0055	0.0080	0.0216	0.0046	8.95×10^{-5}	0.98	1.65
	(7.76)	(-4.2)	(-1.63)	(-0.37)	(0.1)	(-0.57)	(1.79)	(4.14)	(0.9)			
Barley	0.4357	-0.0421	-0.0079	-0.0024	0.0057	0.0107	0.0017	-0.0001	0.0194	1.37×10^{-4}	0.98	2.18
	(7.51)	(-4.76)	(-1.19)	(-0.35)	(0.76)	(0.89)	(0.31)	(-0.02)	(3.07)			

Note: t-statistics for estimated coefficients are shown in parentheses.

γ_{i1} ... γ_{i7} are the coefficients on prices where 1=beef, 2=pork, 3=chicken, 4=rice, 5=wheat, 6=fish, 7=barley.

β_i - coefficient on total expenditure

α_i - constant term

Table 4: Food Demand System Estimates: With Habit Formation

Commodity	Estimated Coefficients										Summary Statistics		
	α_i	d_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	SSE	R^2	DW
Beef	-0.0796	0.0036	0.0032	0.0086	0.0084	-0.0035	-0.0187	0.0075	-0.0013	0.0049	3.1×10^{-5}	0.95	2.23
	(-2.2)	(2.2)	(2.1)	(2.6)	(2.3)	(-0.9)	(-2.9)	(2.62)	(-0.4)	(1.2)			
Pork	-0.0014	0.0007	-0.0099	0.0039	0.0061	-0.0022	0.0009	0.0058	-0.0032	0.0110	1.5×10^{-5}	0.91	2.42
	(-0.06)	(2.2)	(-2.99)	(1.69)	(2.45)	(-0.87)	(0.21)	(3.04)	(-1.46)	(3.65)			
Chicken	0.0112	0.0012	-0.0030	0.0023	0.0009	0.0048	-0.001	-0.0024	-0.0011	-0.0011	4.5×10^{-6}	0.82	1.62
	(0.83)	(1.2)	(-1.7)	(1.87)	(0.6)	(3.28)	(-0.4)	(-2.1)	(-0.89)	(-0.87)			
Rice	0.6945	0.0002	-0.1410	-0.0023	-0.0205	0.0210	0.1561	0.0114	0.0217	0.0288	6.7×10^{-4}	0.96	2.32
	(5.14)	(0.68)	(-5.88)	(-0.14)	(-1.23)	(1.2)	(4.72)	(0.79)	(1.46)	(1.61)			
Wheat flour	0.0610	0.0001	-0.0076	0.0004	0.0057	0.0005	0.0064	-0.0017	0.0050	-0.0127	4.5×10^{-5}	0.91	2.68
	(1.58)	0.47)	-1.42)	(0.10)	(1.31)	(0.10)	(0.86)	-0.44)	(1.31)	(-2.5)			
Barley	0.4389	-0.0001	-0.0425	-0.0074	-0.0018	0.0075	0.0110	0.0006	0.0190	-0.0026	1.3×10^{-4}	0.98	2.1
	(7.26)	(-0.40)	(-4.63)	(-1.07)	(-0.25)	(0.84)	(0.88)	(0.10)	(2.9)	(0.28)			
Fish	0.4660	0.0002	-0.0404	-0.0052	-0.0022	0.0001	-0.0044	0.0065	0.0040	0.0222	8.3×10^{-5}	0.98	1.70
	(4.01)	(0.96)	(-3.11)	(0.80)	(-0.39)	(0.2)	(-0.45)	(1.37)	(0.78)	(4.22)			

Note: t-statistics for estimated coefficients are shown in parentheses.

γ_{i1} ... γ_{i7} are the coefficients on prices, where 1=beef, 2=pork, 3=chicken, 4=rice, 5=wheat, 6=fish, 7=barley.

β_i - coefficient on total expenditure

α_i - constant term

d_i - habit parameter

inelastic for most of the commodities. The demand for pork is the most responsive to changes in its own price, followed by beef and wheat flour. The signs on the β_i parameters indicate that a proportional increase in total expenditure will increase expenditure on beef and decrease expenditure on the other commodities.

The estimates of these coefficients after including a proxy for the impact of urbanization, U_i, the percentage of female labor force participation are presented in Table 5. The addition of the female labor participation rate increases the significance of the income variable in the meats and rice budget share equations. The U_i parameter has a significant negative effect on expenditures for rice, fish and barley, and a positive effect on expenditures for beef, pork, chicken and wheat flour (only the coefficient on pork is not significant).

Demand elasticities were calculated from the system of equations estimated with adding-up and homogeneity conditions imposed (Table 3). The expenditure elasticities are less than unity for the staple cereals, as well as for pork and chicken. The income-inelasticity of these commodities is consistent with the negative responses of the share elasticities to income. A change in income has less impact on marginal expenditures than on average expenditures for these commodities. The opposite is true for beef where there is a positive budget share impact for income. As income levels increase, consumers respond by increasing budget shares for beef.

Income-compensated, cross-price elasticities were also computed to estimate the effects of changes in relative prices with constant real income. These elasticities can be used to identify commodities that are net

Table 5: Food Demand System Estimates: With Habit Formation And Urbanization

Commodity	Estimated Coefficients											Summary Statistics		
	α_i	d_i	U_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	γ_{i6}	γ_{i7}	SSE	R^2	DW
Beef	-0.2161	0.0012	0.0034	0.0177	0.0129	0.0062	-0.0032	-0.0110	0.0027	-0.0028	0.0054	2.2×10^{-5}	0.96	2.5
	(-3.1)	(0.69)	(2.18)	(2.27)	(3.63)	(1.77)	(-0.91)	(-1.63)	(0.81)	(-0.94)	(1.52)			
Pork	0.0343	0.0005	0.0013	-0.0141	0.0016	0.0059	-0.0018	0.0004	0.0072	-0.0031	0.0136	1.3×10^{-5}	0.95	2.3
	(0.90)	(2.2)	(1.1)	(-2.61)	(0.52)	(2.39)	(-0.71)	(0.10)	(3.2)	(-1.4)	(3.6)			
Chicken	0.0507	0.0004	0.0017	-0.0085	.0001	0.0006	-0.0049	-0.0016	-0.0015	-0.0006	+0.001	1.9×10^{-6}	0.93	2.0
	(3.76)	(1.5)	(4.01)	(-4.67)	(0.1)	(0.6)	(4.91)	(-0.9)	(-1.8)	(-0.7)	(0.9)			
Rice	0.2312	0.0001	-0.0143	-0.0752	0.0153	-0.0198	0.0100	0.1579	0.0015	0.0192	0.0253	4.6×10^{-4}	0.97	2.3
	(1.0)	(0.2)	(-2.33)	(-2.14)	(0.98)	(-1.4)	(0.6)	(5.5)	(0.11)	(1.5)	(1.7)			
Wheat flour	0.0963	0.0001	0.0011	-0.0120	-0.0013	0.0058	0.0010	0.0049	-0.0003	0.0050	-0.0115	4.4×10^{-5}	0.92	2.7
	(1.4)	(0.38)	(2.6)	(-1.4)	(-0.3)	(1.5)	(0.2)	(0.6)	(-0.7)	(1.3)	(-2.0)			
Barley	0.3072	0.0001	-0.0049	-0.0225	-0.002	0.0001	-0.001	0.011	-0.001	0.001	0.016	1.1410^{-4}	0.98	2.2
	(3.36)	(0.24)	(-2.29)	(-2.1)	(-0.68)	(0.05)	(-0.8)	(1.41)	(-0.19)	(0.31)	(2.47)			
Fish	0.3373	0.0002	-0.0041	-0.0246	-0.0011	-0.0029	-0.0018	0.0006	0.002	0.004	0.0187	6.3×10^{-5}	0.99	1.9
	(2.73)	(1.1)	(-2.1)	(-1.7)	(0.2)	(-0.6)	(-0.3)	(0.6)	(0.4)	(0.88)	(3.7)			

Note: t-statistics for estimated coefficients are shown in parentheses.
Adding-up and homogeneity imposed.
Urbanization is proxied by percentage of female labor force participation.

γ_{i1} ... γ_{i7} are the coefficients on prices where 1=beef, 2=pork, 3=chicken, 4=rice, 5=wheat, 6=fish, 7=barley.

α - constant term

β_i - coefficient on total expenditure

d_i - habit parameter

U_i - urbanization parameter

substitutes or net complements. The following cross-commodity relationships were found to be net substitutes: beef and pork, beef and chicken, pork and fish, beef and wheat, pork and wheat, chicken and fish, rice and wheat, rice and barley, wheat and barley. Beef and rice are found to be net complements, as well as pork and chicken, pork and rice, chicken and rice.

Slutsky symmetry was also imposed on the parameters of the system. Symmetry cannot be tested on an equation-by-equation basis. A test statistic such as the asymptotic likelihood ratio test statistic for the system as a whole is required. The Slutsky symmetry restrictions were imposed on the system which was estimated using the iterative seemingly unrelated regression technique. The imposition of Slutsky symmetry automatically imposes homogeneity in the linear AIDS model. Hence, the unrestricted model for testing Slutsky symmetry alone had homogeneity imposed.

The Marshallian (uncompensated) elasticities calculated for the demand system with the imposition of adding-up, homogeneity and Slutsky symmetry are presented in Tables A1 to A6. The Hicksian (compensated) elasticities are reported in Tables A7 to A11.

The estimated elasticities for the demand system (with adding-up, homogeneity, and symmetry conditions) are, in general, in accordance with a priori expectations. All own-price elasticities are negative while most of the compensated cross-price elasticities are positive. The income elasticities indicate that beef is a luxury good in Korea. Based on the elasticities estimated at the means, if income (expenditure) increased by 10%, the quantity of beef demanded would increase by 18.5%. Pork and chicken meat

demand would increase by 9.4% and 4.1%, respectively. These results imply that increased meat consumption are an automatic consequence of income growth in Korea.

The behavior of the income elasticities over the sample period is presented in Figure 4a. The income elasticity for beef appears to decline over the period of the study from about 2.5 in 1965 to about 1.8 in 1987. The income elasticity for pork remained stable at about 0.94. However, the income elasticity for chicken appears to increase from about 0.2 in the 1960s to about 0.6 in the 1970s, then steadily decline to about 0.35 in 1985-87. The income elasticity of demand for fish has been negative since the mid-1970s (Figure 4b).

Rice is highly income-inelastic and its magnitude decreases from 0.28 in 1965 to .03 in 1978 and becomes negative in the 1980s. A study by Ito et al (1989) reported income elasticities for rice declining from .095 in 1961 to 0.046 in 1984. Another study reported estimates of 0.12 for urban consumers and 0.33 for rural consumers (Moon, 1975); while estimates from the Korean Rural Economic Institute (1984) range from -0.25 in urban areas to 0.26 in rural areas. Given the much lower income elasticity for rice in urban areas, and that the urban population now accounts for more than three-quarters of total population, the negative elasticities found in this study for the 1980s

Figure 4a

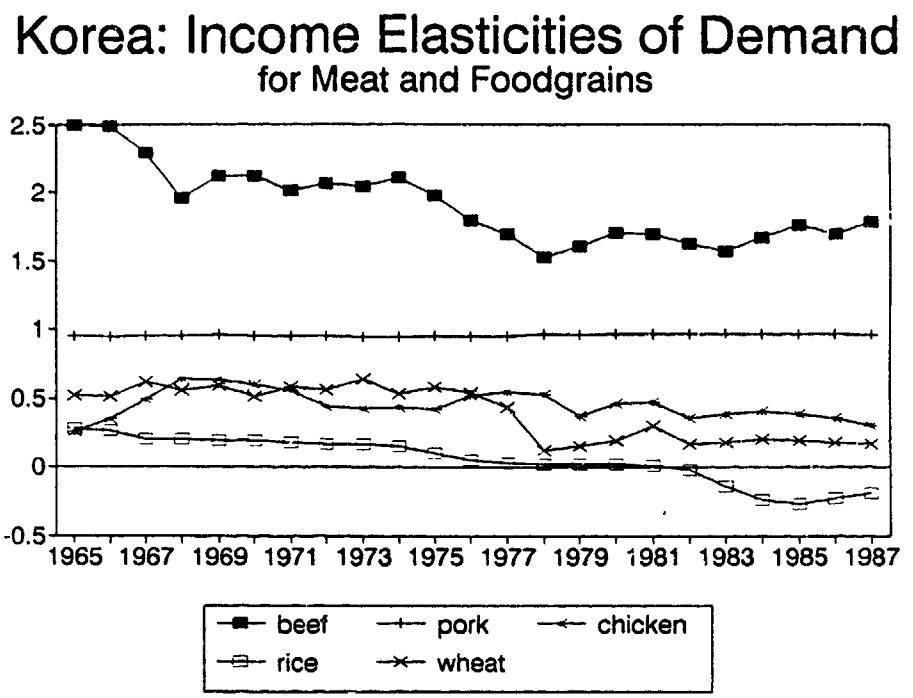
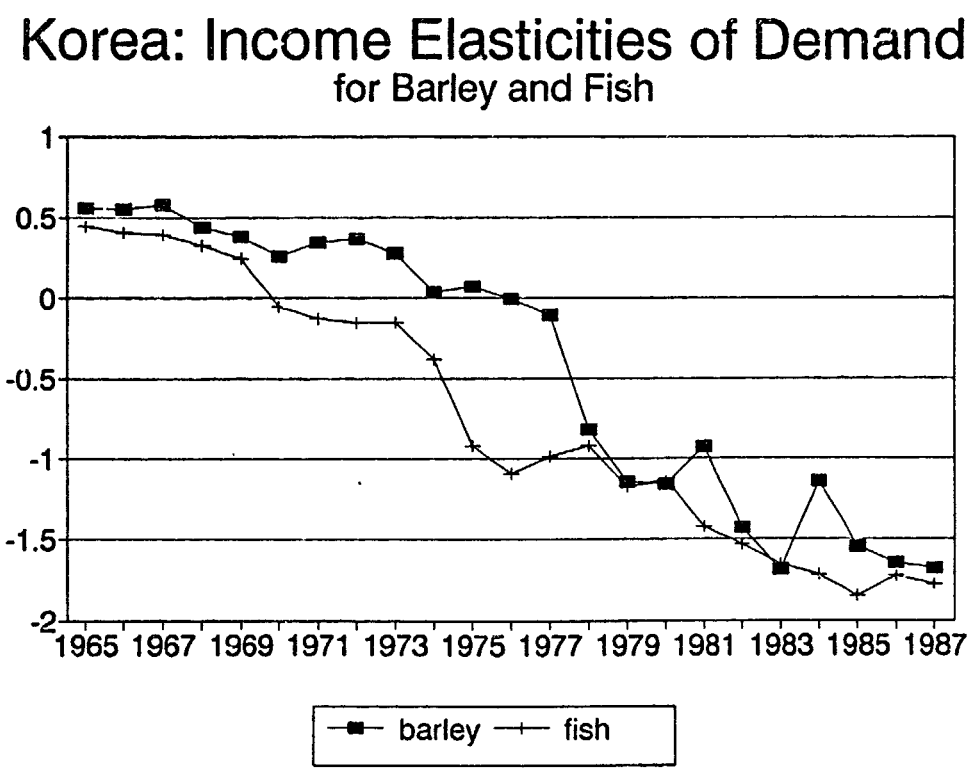

Korea: Income Elasticities of Demand
for Meat and Foodgrains
2.5
2
1.5
1
0.5
0
-0.5
1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987
beef
pork
chicken
rice
wheat

Figure 4b


Korea: Income Elasticities of Demand
for Barley and Fish
1
0.5
0
-0.5
-1
-1.5
-2
1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987
barley
fish

appear consistent with these other findings. These results confirm that the changes in diet away from rice and fish are largely a result of income growth.

Estimated own-price elasticities of demand for beef, pork and chicken over the period 1965-87 are shown in Figure 5. Pork remained the most price-responsive. The demand for beef becomes more price-responsive while chicken demand appears to become less price-responsive.

As expected, the demand for wheat is more price-responsive than the demand for rice (Figure 6). The own-price elasticity of demand for rice, estimated at the sample means, is -0.10 while for wheat it is -0.76. The own-price elasticity of wheat demand was stable during the first half of the period, but shows a declining trend since the mid-1970s. This suggests that the demand for wheat and wheat flour products became less price-responsive as its share in the food budget increased.

The fact that most of these income and price elasticities have been changing over the sample period indicates that one may need a different set of elasticities than those estimated at the sample period means when making forecasts. A useful means of deriving elasticities for forecasting purposes would be to project the trends in the elasticities derived here. This is done in the next section.

Figure 5

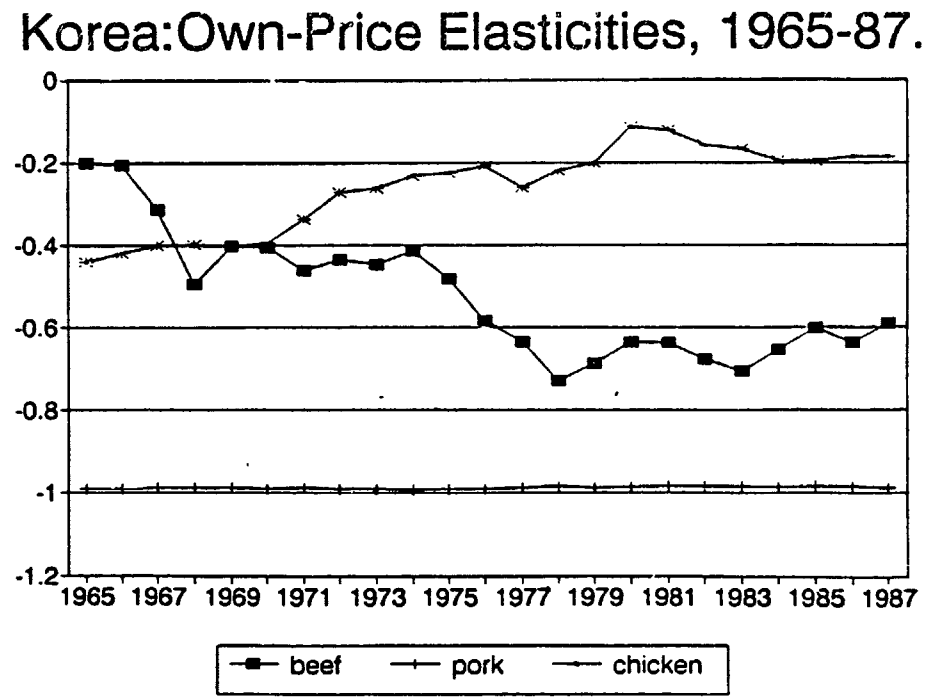
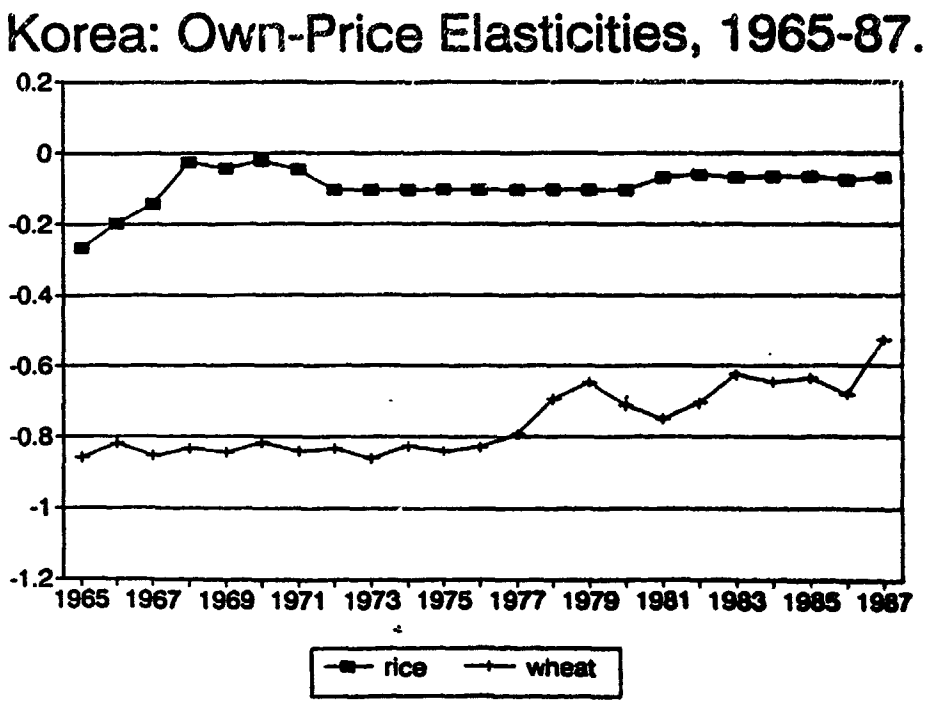

Korea:Own-Price Elasticities, 1965-87.
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987
beef
pork
chicken

Figure 6


Korea: Own-Price Elasticities, 1965-87.
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987
rice
wheat

VI. Demand Projections

Based on the recent past, the pattern of food consumption can be expected to undergo further changes as per capita incomes continue to increase in Korea. A simulation exercise is undertaken to derive the income elasticities which could be applicable in forecasting such changes.

To derive the forecast elasticities, a benchmark growth rate in real total expenditures (or income) of 6% p.a. between 1988 and 2000 is assumed. This is the historical growth rate for Korea determined by regressing the log of per capita personal consumption expenditures divided by the consumer price index on a linear time trend. Relative prices are assumed fixed at their average values. The projected expenditure shares are used to generate the elasticities over the forecast period. Results of simulations for a lower growth path, 4% p.a. expenditure growth rate, and for a 8% p.a. growth path for expenditure are presented in Table 6. These estimates could be used to make projections of Korea food consumption patterns. They can also be indicative for other rapidly-growing developing economies, with similar food-consumption profiles.

The simulation results indicate that a continued increase in total expenditure at the historical growth rate (6% p.a. in 1965-1987) will result in a decline in the income elasticities of demand for meat and foodgrains. Relative to the estimates at the sample means (in parenthesis), the income elasticities of demand are projected to move as follows: beef, 1.75 (1.85); pork, 0.90 (0.94); chicken, 0.39 (0.45); rice, -0.08 (0.06); wheat, 0.35 (0.39). At a higher total expenditure growth rate (8% p.a.), the income elasticities will tend to decline further.

Table 6: Projected Average Income Elasticities for Various Total Expenditure Growth Rates, for period 1989-2000 (1988 Constant Relative Prices)

Expenditure Growth Rate	Food Categories				
	Beef	Pork	Chicken	Rice	Wheat
4%	1.91	0.95	0.43	-0.08	0.40
6%	1.75	0.90	0.39	-0.15	0.35
8%	1.62	0.87	0.42	-0.23	0.27
At historical sample mean 1/	1.85	0.94	0.45	0.06	0.39

1/ Average elasticities calculated at the sample means.

These estimates suggest that demand for beef will tend to become less expenditure (or income elastic), but will remain quite high. This is reasonable considering the very low level of current per capita beef consumption. The income elasticity of demand for rice will be more negative at growth paths higher than the historical rate. This reflects the declining budget share of rice in the diet at higher income levels, due to the growing preference for meat, wheat and wheat products (bread) at higher income levels. 4/

At a slower growth path (4%) relative to the historical rate, the income elasticity estimates for pork, chicken and wheat show very little change relative to the historical mean estimates. The estimate for rice (-0.08) becomes less negative than the estimate at 6% expenditure growth (-0.15). The latter estimate is more in line with recent trends (as indicated in Figure 4a, becoming negative since early 1980s and reaching about -0.19 in 1987) than the estimate at the mean of the sample period (0.06).

The simulation results confirm that given the changes in the elasticities over time, one may need different elasticity estimates than those estimated at the historical sample mean when forecasting demand for food.

4/ Since most of the decline in per capita rice consumption have been in urban areas, a better means to account for urbanization is to separate the sample between urban and rural. This is not done in the analysis due to data limitations.

VII. Conclusions

This paper presents the estimates of the parameters for food demand in Korea, focusing on meats and foodgrains. An Almost Ideal Demand System specification, modified to incorporate habit formation and urbanization effects, was estimated using time-series data for 1965 to 1987. The estimation results can be summarized as follows.

The budget shares were found to be strongly responsive to changes in food prices and to real per capita expenditures. Beef was found to be a relative luxury good, while pork, chicken, fish, rice, wheat flour and barley are relative necessities, i.e., increased real per capita expenditures will lead to an increased budget share for beef and decreased shares for the other commodities.

Likelihood ratio tests indicated that habit formation was present for beef, pork, chicken, rice and wheat flour. The habit parameter has a small positive effect on the budget shares of these commodities and a negative effect for barley.

The incorporation of urbanization effects, proxied by the female labor force participation rate, improved the significance of the estimates of the other coefficients. The urbanization parameter showed a significant negative effect on expenditures for rice, fish and barley, and positive effects on beef, pork, chicken and wheat flour.

The estimated elasticities for the demand system are generally in accordance with *a priori* expectations. All own-price elasticities are

negative while most of the compensated cross-price elasticities are positive. The following cross-commodity relationships were found to be substitutes: beef and chicken, beef and pork, rice and wheat, rice and barley, wheat and barley. Beef and rice are found to be complements, as are pork and rice, and chicken and wheat.

Except for pork, the calculated own-price elasticities indicate that the demand for meats and foodgrains are all price-inelastic. The demand for beef becomes more price responsive during the period of the study (with the elasticity estimate going from -0.2 to -0.6), while chicken demand appears to become relatively less price-responsive over time. The own-price elasticity of demand for pork has been stable at around -1.0.

The demand for rice is very price-inelastic and appears to become even less elastic over time, declining from -.0.27 in 1965 to -0.07 in 1987. The demand for barley is also very price-inelastic, but less so than that of rice. The own-price elasticity of demand for barley declined from -0.66 in 1965 to -0.16 in 1987.

Wheat demand is the most price-responsive of the foodgrains, with an own-price elasticity greater than -0.5. Over time the price elasticity of wheat has followed the same behavior as rice and barley, declining from -0.86 in 1965 to -0.54 in 1987.

The estimated income (expenditure) elasticities over the period are positive for all the meats. The demand for beef is income-elastic, while the demand for pork and chicken is income-inelastic. The income elasticity for beef appears to decline over the period of the study, but it was still greater

than 1.5 in 1987; the income elasticity of demand for pork has remained quite stable. The income elasticity for chicken appears to increase slightly from about 0.6 in 1965 to about 0.8 in 1970, then steadily decline in the 1980s.

The estimated income (expenditure) elasticity for rice was found to be very inelastic. Its magnitude declines from 0.26 in 1965 to 0.03 in 1978 and becomes negative in the 1980s. The estimated income (expenditure) elasticity for barley exhibits a declining trend and became negative at an even earlier period. Wheat demand shows a positive income (expenditure) elasticity during the sample period. Its magnitude also declined, from about 0.6 in 1965 to about 0.2 in 1987. The income elasticity of demand for fish has been negative since the mid-1970s.

The demand estimation results have important implications. First, the relatively large own-price elasticities for meats, particularly for beef and pork, imply that a reduction of protection to meat producers in Korea would result in a significant increase in per capita meat consumption. Second, since the income elasticities of demand for beef are also relatively high, the expected increases in real incomes will put pressure on beef prices unless the rate of increase in the beef import quota is increased or quotas are eliminated. Third, the estimated negative income elasticity for rice implies that if rice production is not adjusted downwards, the rice surplus will grow. Given the declining trend in the income elasticity of rice and in per capita rice consumption, the re-structuring of grain production to adjust to these changes will be an most important issue in farm policy. Fourth, both the increases in per capita incomes and the increasing urbanization in Korea explain the declining dietary role of rice, barley, and fish, and the

increasing importance of beef, pork, chicken and wheat flour. As these trends in income growth and urbanization continue, the consumption patterns should change further in this direction. The same can be expected for other rapidly-growing Asian countries with similar dietary profiles.

The demand analysis also indicates that a different set of elasticities than those based on the means of the sample period are required when forecasting demand for meats and foodgrains. The systems approach ensures that the income elasticities satify the general restrictions of consumer behavior in the forecast period as well as within the sample.

Table A1: Beef Demand: Uncompensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	-0.1999	0.2476	0.2285	-1.8497	0.1912	-0.2866	-0.4190
1966	-0.2066	0.2467	0.2258	-1.8034	0.1969	-0.2727	-0.4111
1967	-0.3126	0.2121	0.1946	-1.5480	0.1652	-0.2421	-0.3560
1968	-0.4936	0.1576	0.1424	-1.1251	0.1256	-0.1644	-0.2601
1969	-0.4038	0.1843	0.1670	-1.3231	0.1459	-0.1873	-0.3003
1970	-0.4055	0.1851	0.1673	-1.3057	0.1486	-0.1791	-0.2881
1971	-0.4618	0.1671	0.1525	-1.1811	0.1324	-0.1672	-0.2599
1972	-0.4345	0.1763	0.1613	-1.2694	0.1397	-0.1768	-0.2721
1973	-0.4463	0.1734	0.1582	-1.2177	0.1332	-0.1682	-0.2688
1974	-0.4143	0.1844	0.1671	-1.3014	0.1455	-0.1671	-0.2774
1975	-0.4835	0.1617	0.1480	-1.1368	0.1272	-0.1490	-0.2402
1976	-0.5838	0.1313	0.1192	-0.9277	0.1044	-0.1190	-0.1939
1977	-0.6356	0.1146	0.1046	-0.8143	0.0938	-0.1029	-0.1711
1978	-0.7298	0.0834	0.0788	-0.5977	0.0728	-0.0723	-0.1288
1979	-0.6872	0.0988	0.0914	-0.6813	0.0844	-0.0818	-0.1455
1980	-0.6349	0.1124	0.1055	-0.8105	0.0967	-0.0949	-0.1673
1981	-0.6386	0.1097	0.1044	-0.8137	0.0947	-0.0950	-0.1659
1982	-0.6766	0.0993	0.0944	-0.7210	0.0863	-0.0815	-0.1479
1983	-0.7066	0.0906	0.0859	-0.6486	0.0797	-0.0740	-0.1354
1984	-0.6536	0.1072	0.1006	-0.7534	0.0931	-0.0875	-0.1582
1985	-0.6035	0.1202	0.1147	-0.8559	0.1062	-0.0989	-0.1804
1986	-0.6377	0.1109	0.1053	-0.7874	0.0966	-0.0906	-0.1658
1987	-0.5897	0.1282	0.1190	-0.8906	0.1111	-0.1015	-0.1868
At the sample means	-0.53	0.14	0.13	-1.06	0.12	-0.14	-0.23

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A2: Pork demand: Uncompensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	0.2123	-1.0010	-0.0168	-0.1872	0.4929	0.0019	0.7553
1966	0.2269	-1.0012	-0.0179	-0.2012	0.5264	0.0012	0.8069
1967	0.1967	-1.0010	-0.0155	-0.1750	0.4565	0.0012	0.6994
1968	0.2001	-1.0010	-0.1056	-0.1791	0.4638	0.0005	0.7106
1969	0.1942	-1.0009	-0.0152	-0.1737	0.4503	0.0003	0.6896
1970	0.2119	-1.0010	-0.0166	-0.1901	0.4912	0.0001	0.7520
1971	0.1978	-1.0009	-0.0155	-0.1776	0.4584	0.0001	0.7016
1972	0.2130	-1.0011	-0.0168	-0.1899	0.4939	0.0002	0.7559
1973	0.2254	-1.0011	-0.0177	-0.2022	0.5227	0.0001	0.7997
1974	0.2499	-1.0013	-0.0196	-0.2234	0.5793	0.0006	0.8864
1975	0.2188	-1.0011	-0.0172	-0.1963	0.5072	0.0004	0.7757
1976	0.2222	-1.0011	-0.0174	-0.1988	0.5144	0.0005	0.7868
1977	0.2000	-1.0009	-0.0156	-0.1790	0.4628	0.0006	0.7080
1978	0.1431	-1.0005	-0.0112	-0.1288	0.3303	0.0007	0.5056
1979	0.1947	-1.0009	-0.0153	-0.1758	0.4498	0.0012	0.6884
1980	0.1575	-1.0006	-0.0124	-0.1412	0.3641	0.0009	0.5571
1981	0.1384	-1.0005	-0.0108	-0.1235	0.3201	0.0007	0.4897
1982	0.1463	-1.0005	-0.0115	-0.1312	0.3382	0.0009	0.5174
1983	0.1484	-1.0005	-0.0116	-0.1335	0.3428	0.0010	0.5245
1984	0.1631	-1.0007	-0.0128	-0.1472	0.3771	0.0010	0.5770
1985	0.1412	-1.0005	-0.0111	-0.1276	0.3267	0.0010	0.4948
1986	0.1493	-1.0006	-0.0117	-0.1347	0.3452	0.0011	0.5282
1987	0.1942	-1.0009	-0.0153	-0.1752	0.4493	0.0011	0.6876
At the sample means	0.19	-1.000	-0.02	-0.17	0.44	0.001	0.67

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A3: Chicken demand: Uncompensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	0.6228	-0.0466	-0.3176	0.2211	-0.6503	-0.2240	0.4183
1966	0.5420	-0.0413	-0.1469	0.1788	-0.5591	-0.1999	0.3620
1967	0.4238	-0.0313	-0.1043	0.1322	-0.4418	-0.1540	0.2820
1968	0.3052	-0.0225	-0.3571	0.0857	-0.3179	-0.1162	0.2006
1969	0.3072	-0.0226	-0.3513	0.0878	-0.3203	-0.1190	0.2009
1970	0.3379	-0.0253	-0.2867	0.0912	-0.3535	-0.1337	0.2170
1971	0.3721	-0.0274	-0.2161	0.0991	-0.3875	-0.1449	0.2378
1972	0.4662	-0.0349	-0.0177	0.1399	-0.4864	-0.1811	0.2979
1973	0.4825	-0.0365	-0.0162	0.1304	-0.5011	-0.1901	0.3075
1974	0.4731	-0.0365	-0.0028	0.1357	-0.4942	-0.1919	0.3003
1975	0.4902	-0.0369	-0.0312	0.1317	-0.5103	-0.1978	0.3074
1976	0.4066	-0.0305	-0.1479	0.1122	-0.4221	-0.1645	0.2533
1977	0.3810	-0.0279	-0.2036	0.1036	-0.3956	-0.1548	0.2370
1978	0.4046	-0.0269	-0.1614	0.0961	-0.4189	-0.1676	0.2499
1979	0.5374	-0.0390	-0.1178	0.1224	-0.5595	-0.2250	0.3306
1980	0.4560	-0.0315	-0.0473	0.1198	-0.4757	-0.1917	0.2806
1981	0.4521	-0.0030	-0.0556	0.1273	-0.4707	-0.1892	0.2782
1982	0.5456	-0.0368	-0.1358	0.1423	-0.5676	-0.2317	0.3336
1983	0.5220	-0.0352	-0.0838	0.1269	-0.5427	-0.2214	0.3189
1984	0.5056	-0.0352	-0.0547	0.1174	-0.5278	-0.2147	0.3099
1985	0.5202	-0.0349	-0.0885	0.1193	-0.5450	-0.2222	0.3201
1986	0.5461	-0.0372	-0.1411	0.1276	-0.5701	-0.2329	0.3357
1987	0.5932	-0.0433	-0.2417	0.1415	-0.6230	-0.2542	0.3655
At the sample means	0.46	-0.03	-0.14	0.13	-0.48	-0.19	0.29

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions, imposed.

Table A4: Rice demand: Uncompensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	-0.0636	-0.0046	0.0030	-0.2658	0.0707	0.1224	0.0774
1966	-0.0704	-0.0056	0.0037	-0.1995	0.0753	0.1310	0.0839
1967	-0.0751	-0.0049	0.0048	-0.1443	0.0843	0.1441	0.0901
1968	-0.0842	-0.0059	0.0071	-0.0261	0.0954	0.1552	0.0113
1969	-0.0838	-0.0054	0.0069	-0.0460	0.0942	0.1481	0.0959
1970	-0.0908	-0.0068	0.0069	-0.0236	0.0998	0.1550	0.0959
1971	-0.0921	-0.0062	0.0066	-0.0476	0.1043	0.1628	0.0972
1972	-0.0775	-0.0058	0.0046	-0.1052	0.0867	0.1369	0.0808
1973	-0.0904	-0.0074	0.0053	-0.1055	0.1403	0.1564	0.0963
1974	-0.0832	-0.0076	0.0049	-0.1057	0.0922	0.1361	0.0837
1975	-0.0904	-0.0072	0.0053	-0.1056	0.1028	0.1510	0.0880
1976	-0.0834	-0.0069	0.0058	-0.1055	0.0968	0.1420	0.0830
1977	-0.0830	-0.0061	0.0062	-0.1054	0.0964	0.1427	0.0851
1978	-0.0950	-0.0025	0.0073	-0.1055	0.1138	0.1658	0.1045
1979	-0.1065	-0.0076	0.0064	-0.1056	0.1219	0.1767	0.1807
1980	-0.0876	-0.0035	0.0057	-0.1055	0.0986	0.1408	0.0850
1981	-0.0786	-0.0015	0.0052	-0.0695	0.0896	0.1276	0.0765
1982	-0.0860	-0.0025	0.0051	-0.0619	0.0989	0.1378	0.0841
1983	-0.0937	-0.0030	0.0059	-0.0697	0.1085	0.1531	0.0946
1984	-0.1057	-0.0048	0.0065	-0.0670	0.1184	0.1677	0.1023
1985	-0.1113	-0.0024	0.0065	-0.0680	0.1213	0.1712	0.1053
1986	-0.1057	-0.0033	0.0061	-0.0775	0.1182	0.1651	0.1022
1987	-0.1049	-0.0071	0.0056	-0.0699	0.1121	0.1595	0.0991
At the sample means	-0.09	-0.01	0.01	-0.10	0.10	0.15	0.09

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A5: Wheat demand: Uncompensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	0.1200	0.3192	-0.1211	0.8959	-0.8596	0.1523	0.2213
1966	0.1597	0.4234	-0.1603	1.1611	-0.8204	0.1912	0.2898
1967	0.1238	0.3259	-0.1213	0.8720	-0.8575	0.1508	0.2206
1968	0.1533	0.3892	-0.1421	1.0090	-0.8339	0.1589	0.2580
1969	0.1395	0.3618	-0.1320	0.9413	-0.8443	0.1416	0.2345
1970	0.1664	0.4297	-0.1584	1.0410	-0.8185	0.1587	0.2645
1971	0.1443	0.3696	-0.1366	0.9421	-0.8413	0.1419	0.2249
1972	0.1501	0.3853	-0.1446	1.0226	-0.8350	0.1501	0.2345
1973	0.1235	0.3155	-0.1188	0.8120	-0.8607	0.1179	0.1947
1974	0.1576	0.4037	-0.1525	1.0623	-0.8272	0.1381	0.2418
1975	0.1453	0.3685	-0.1387	0.9459	-0.8411	0.1269	0.2128
1976	0.1644	0.4043	-0.1509	1.0485	-0.8276	0.1360	0.2321
1977	0.2053	0.4966	-0.1838	1.2774	-0.7941	0.1621	0.2850
1978	0.3348	0.7797	-0.2844	1.8983	-0.6941	0.2250	0.4408
1979	0.3774	0.8900	-0.3344	2.1746	-0.6485	0.2542	0.4985
1980	0.2935	0.7189	-0.2654	1.8082	-0.7147	0.2030	0.3936
1981	0.2531	0.6236	-0.2284	1.5902	-0.7514	0.1779	0.3391
1982	0.3117	0.7506	-0.2780	1.8776	-0.7043	0.1992	0.4047
1983	0.4072	0.9619	-0.3559	2.3612	-0.6268	0.2538	0.5225
1984	0.3726	0.9027	-0.3354	2.1965	-0.6467	0.2433	0.4912
1985	0.3744	0.9354	-0.3451	2.2476	-0.6375	0.2469	0.5055
1986	0.3277	0.8041	-0.2983	1.9497	-0.6843	0.2124	0.4376
1987	0.4926	1.2162	-0.4588	2.0005	-0.5275	0.3225	0.6703
At the sample means	0.24	0.59	-0.22	1.44	-0.76	0.19	0.34

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A6: Barley demand: Uncompensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	-0.0185	0.0097	-0.0119	0.4498	0.0386	-0.6589	0.1186
1966	-0.0208	0.0102	-0.0129	0.4883	0.0391	-0.6221	0.1311
1967	-0.0197	0.0145	-0.0123	0.5638	0.0504	-0.5423	0.1576
1968	-0.0247	0.0166	-0.0137	0.6305	0.0575	-0.4981	0.1697
1969	-0.0293	0.0180	-0.0173	0.7296	0.0640	-0.4149	0.1859
1970	-0.0242	0.0172	-0.0162	0.6432	0.0601	-0.4738	0.1631
1971	-0.0244	0.0155	-0.0174	0.6616	0.0574	-0.4874	0.1576
1972	-0.0271	0.0165	-0.0199	0.7088	0.0700	-0.4293	0.1808
1973	-0.0378	0.0198	-0.0265	0.9773	0.0851	-0.2540	0.2307
1974	-0.0330	0.0219	-0.0258	0.9099	0.0847	-0.2816	0.2112
1975	-0.0287	0.0234	-0.0259	1.0046	0.0889	-0.2235	0.2274
1976	-0.0258	0.0288	-0.0277	1.1017	0.0916	-0.1494	0.2524
1977	-0.0164	0.0668	-0.0466	1.7048	0.1336	-0.1050	0.4158
1978	-0.0353	0.0573	-0.0613	1.9679	0.1524	-0.1595	0.4711
1979	-0.0504	0.0716	-0.0582	1.9580	0.1609	-0.1594	0.4645
1980	-0.0441	0.0728	-0.0517	1.9399	0.1492	-0.1605	0.4146
1981	-0.0619	0.1228	-0.0985	1.9300	0.1495	-0.1607	0.4147
1982	-0.0491	0.1300	-0.1641	1.9305	0.1497	-0.1609	0.4148
1983	-0.0663	0.1005	-0.0879	1.9400	0.1502	-0.1605	0.4145
1984	-0.0945	0.1316	-0.1005	1.9497	0.1512	-0.1603	0.4140
1985	-0.0840	0.1278	-0.1048	1.9500	0.1615	-0.1599	0.4140
1986	-0.1137	0.1088	-0.1199	1.9705	0.1675	-0.1595	0.4139
1987	-0.1136	0.1087	-0.1198	1.9700	0.1670	-0.1594	0.4130
At the sample means	-0.05	0.06	-0.05	1.31	0.11	-0.29	0.30

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A7: Beef demand: Compensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	-0.1756	0.2782	0.2378	-1.3100	0.2404	-0.1167	-0.3002
1966	-0.1822	0.2752	0.2364	-1.3185	0.2337	-0.1292	-0.3004
1967	-0.2867	0.2423	0.2071	-1.1345	0.2095	-0.0948	-0.2561
1968	-0.4637	0.1831	0.1573	-0.8204	0.1573	-0.0698	-0.1831
1969	-0.3762	0.2128	0.1830	-0.9848	0.1829	-0.0950	-0.2255
1970	-0.3779	0.2111	0.1818	-0.9938	0.1796	-0.1014	-0.2349
1971	-0.4329	0.1936	0.1650	-0.8921	0.1668	-0.0841	-0.2125
1972	-0.4063	0.2015	0.1716	-0.9151	0.1734	-0.0890	-0.2247
1973	-0.4177	0.1971	0.1681	-0.9181	0.1738	-0.0912	-0.2176
1974	-0.3865	0.2063	0.1774	-0.9643	0.1781	-0.1080	-0.2371
1975	-0.4539	0.1852	0.1573	-0.8495	0.1609	-0.0911	-0.2129
1976	-0.5508	0.1523	0.1295	-0.6543	0.1322	-0.0707	-0.1712
1977	-0.6000	0.1367	0.1150	-0.5601	0.1154	-0.0615	-0.1484
1978	-0.6873	0.1112	0.0877	-0.4112	0.0854	-0.0497	-0.1078
1979	-0.6484	0.1202	0.0984	-0.5000	0.0958	-0.0616	-0.1302
1980	-0.5993	0.1405	0.1142	-0.5693	0.1117	-0.0795	-0.1545
1981	-0.6028	0.1415	0.1132	-0.5463	0.1122	-0.0711	-0.1528
1982	-0.6385	0.1282	0.1014	-0.4921	0.1001	-0.0687	-0.1385
1983	-0.6663	0.1181	0.0930	-0.4502	0.0901	-0.0624	-0.1246
1984	-0.6170	0.1338	0.1083	-0.5597	0.1048	-0.0732	-0.1478
1985	-0.5696	0.1526	0.1225	-0.6566	0.1182	-0.0855	-0.1689
1986	-0.6021	0.1404	0.1125	-0.5885	0.1100	-0.0780	-0.1538
1987	-0.5564	0.1521	0.1260	-0.6750	0.1203	-0.0897	-0.1745
At the sample means	-0.49	0.17	0.15	-0.77	0.15	-0.08	-0.19

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A8: Pork demand: Compensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	0.2216	-0.9894	-0.0133	-0.0179	0.5116	0.0661	0.8004
1966	0.2362	-0.9903	-0.0139	-0.0166	0.5404	0.0582	0.8490
1967	0.2075	-0.9883	-0.0102	-0.0030	0.4750	0.0625	0.7409
1968	0.2147	-0.9886	-0.0084	-0.0308	0.4793	0.0465	0.7481
1969	0.2066	-0.9881	-0.0080	-0.0217	0.4670	0.0418	0.7232
1970	0.2243	-0.9894	-0.0101	-0.0504	0.5051	0.0348	0.7758
1971	0.2114	-0.9884	-0.0095	-0.0409	0.4746	0.0394	0.7239
1972	0.2260	-0.9895	-0.0120	-0.0271	0.5094	0.0405	0.7777
1973	0.2386	-0.9902	-0.0131	-0.0635	0.5415	0.0356	0.8234
1974	0.2623	-0.9915	-0.0150	-0.0727	0.5938	0.0258	0.9044
1975	0.2330	-0.9898	-0.0127	-0.0585	0.5234	0.0273	0.7888
1976	0.2396	-0.9900	-0.0120	-0.0543	0.5292	0.0249	0.7888
1977	0.2200	-0.9885	-0.0098	-0.0363	0.4748	0.0226	0.7207
1978	0.1700	-0.9829	-0.0056	-0.0105	0.3383	0.0136	0.5189
1979	0.2178	-0.9881	-0.0111	-0.0678	0.4565	0.0109	0.6975
1980	0.1776	-0.9847	-0.0074	-0.0044	0.3727	0.0112	0.5645
1981	0.1588	-0.9823	-0.0058	-0.0293	0.3301	0.0129	0.4972
1982	0.1690	-0.9833	-0.0074	-0.0051	0.3464	0.0066	0.5230
1983	0.1733	-0.9836	-0.0073	-0.0112	0.3492	0.0060	0.5311
1984	0.1843	-0.9853	-0.0084	-0.0353	0.3839	0.0072	0.5831
1985	0.1599	-0.9827	-0.0068	-0.0180	0.3333	0.0064	0.5062
1986	0.1696	-0.9837	-0.0076	-0.0214	0.3529	0.0061	0.5351
1987	0.2121	-0.9881	-0.0116	-0.0598	0.4542	0.0049	0.6942
At the Sample means	0.21	-0.99	-0.01	-0.03	0.45	0.03	0.69

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A9: Chicken demand: Compensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	0.6253	-0.0437	-0.3185	0.2576	-0.6454	-0.2068	0.4302
1966	0.5455	-0.0373	-0.1484	0.2470	-0.5639	-0.1789	0.3775
1967	0.4293	-0.0248	-0.1016	0.2210	-0.4323	-0.1223	0.3035
1968	0.3149	-0.0142	-0.3523	0.1847	-0.3076	-0.0855	0.2256
1969	0.3154	-0.0141	-0.3465	0.1886	-0.3093	-0.0915	0.2232
1970	0.3457	-0.0180	-0.2826	0.1793	-0.3448	-0.1119	0.2319
1971	0.3801	-0.0201	-0.2127	0.1787	-0.3781	-0.1220	0.2509
1972	0.4723	-0.0295	-0.0155	0.2159	-0.4792	-0.1622	0.3081
1973	0.4885	-0.0316	-0.01828	0.1925	-0.4928	-0.1741	0.3201
1974	0.4788	-0.0320	-0.0006	0.2053	-0.4875	-0.1797	0.3086
1975	0.4964	-0.0319	-0.0332	0.1920	-0.5032	-0.1856	0.3131
1976	0.4161	-0.0245	-0.1449	0.1911	-0.4141	-0.1506	0.2599
1977	0.3925	-0.0208	-0.2003	0.1858	-0.3887	-0.1414	0.2443
1978	0.4192	-0.0174	-0.1583	0.1603	-0.4145	-0.1598	0.2571
1979	0.5463	-0.0341	-0.1194	0.1637	-0.5569	-0.2204	0.3341
1980	0.4656	-0.0239	-0.0450	0.1852	-0.4716	-0.1859	0.2841
1981	0.4619	-0.0213	-0.0534	0.2008	-0.4659	-0.1826	0.2818
1982	0.5540	-0.0304	-0.0500	0.1925	-0.5645	-0.2289	0.3356
1983	0.5319	-0.0285	-0.0855	0.1757	-0.5402	-0.2185	0.3215
1984	0.5145	-0.0288	-0.0565	0.1642	-0.5250	-0.2112	0.3125
1985	0.5276	-0.0278	-0.0902	0.1627	-0.5423	-0.2193	0.3226
1986	0.5535	-0.0310	-0.1000	0.1691	-0.5673	-0.2302	0.3382
1987	0.5987	-0.0394	-0.1005	0.1772	-0.6215	-0.2528	0.3676
At the Same means	0.47	-0.03	-0.13	0.19	-0.48	-0.17	0.30

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A10: Rice demand: Compensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	-0.0591	-0.0010	0.0047	-0.1662	0.0797	0.1538	0.0993
1966	-0.0664	-0.0010	0.0054	-0.1208	0.0813	0.1552	0.1018
1967	-0.0711	-0.0002	0.0067	-0.0803	0.0912	0.1670	0.1055
1968	-0.0803	-0.0026	0.0090	-0.0805	0.0995	0.1674	0.1112
1969	-0.0803	-0.0018	0.0089	-0.0805	0.0988	0.1598	0.1054
1970	-0.0881	-0.0042	0.0084	-0.0543	0.1028	0.1626	0.1011
1971	-0.0894	-0.0036	0.0078	-0.0745	0.1076	0.1706	0.1016
1972	-0.0731	-0.0019	0.0063	-0.0502	0.0909	0.1505	0.0882
1973	-0.0875	-0.0050	0.0063	-0.0573	0.1084	0.1642	0.1014
1974	-0.0796	-0.0047	0.0062	-0.0669	0.0964	0.1438	0.0889
1975	-0.0874	-0.0048	0.0063	-0.0634	0.1063	0.1568	0.0908
1976	-0.0791	-0.0042	0.0072	-0.0672	0.1005	0.1484	0.0880
1977	-0.0784	-0.0032	0.0076	-0.0606	0.0993	0.1481	0.0880
1978	-0.0936	-0.0016	0.0076	-0.0605	0.1142	0.1663	0.1052
1979	-0.1072	-0.0080	0.0063	-0.0606	0.1152	0.1673	0.1084
1980	-0.0838	-0.0005	0.0067	-0.0514	0.1001	0.1430	0.0863
1981	-0.0729	-0.0035	0.0066	-0.0515	0.0923	0.1313	0.0785
1982	-0.0819	-0.0006	0.0058	-0.0566	0.1004	0.1392	0.0851
1983	-0.0916	-0.0015	0.0062	-0.0569	0.1090	0.1536	0.0952
1984	-0.1057	-0.0048	0.0065	-0.0572	0.1184	0.1677	0.1023
1985	-0.1118	-0.0029	0.0064	-0.0575	0.1211	0.1700	0.1052
1986	-0.1055	-0.0032	0.0062	-0.0575	0.1183	0.1652	0.1023
1987							
At the Sample means	-0.08	-0.003	0.01	-0.07	0.10	0.15	0.09

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

Table A11: Wheat demand: Compensated Own-Price And Cross-Price Elasticities, 1965-1987

Year	Beef	Pork	Chicken	Rice	Wheat	Barley	Fish
1965	0.1190	0.3180	-0.1215	0.8748	-0.8615	0.1456	0.2165
1966	0.1552	0.4182	-0.1623	1.0714	-0.8272	0.1635	0.2693
1967	0.1225	0.3243	-0.1220	0.8509	-0.8598	0.1433	0.2156
1968	0.1482	0.3849	-0.1447	0.9569	-0.8393	0.1427	0.2449
1969	0.1364	0.3586	-0.1338	0.9031	-0.8484	0.1312	0.2260
1970	0.1601	0.4238	-0.1617	1.0338	-0.8255	0.1412	0.2525
1971	0.1405	0.3661	-0.1383	0.9038	-0.8458	0.1309	0.2186
1972	0.1456	0.3814	-0.1462	0.9668	-0.8403	0.1362	0.2270
1973	0.1222	0.3145	-0.1193	0.7992	-0.8624	0.1146	0.1925
1974	0.1523	0.3995	-0.1545	0.9986	-0.8333	0.1269	0.2342
1975	0.1412	0.3653	-0.1399	0.9068	-0.8456	0.1190	0.2091
1976	0.1571	0.3997	-0.1531	0.9885	-0.8337	0.1255	0.2271
1977	0.1905	0.4875	-0.1882	1.1721	-0.80298	0.1449	0.2756
1978	0.2894	0.7500	-0.2938	1.6992	-0.7075	0.2007	0.4183
1979	0.3277	0.8625	-0.3433	1.9428	-0.6630	0.2283	0.4789
1980	0.2634	0.6951	-0.2727	1.6042	-0.7295	0.1849	0.3827
1981	0.2299	0.6030	-0.2341	1.4168	-0.7627	0.1625	0.3306
1982	0.2756	0.7233	-0.2846	1.6612	-0.7173	0.1871	0.3958
1983	0.3492	0.9224	-0.3661	1.6672	-0.7170	0.1872	0.3959
1984	0.3271	0.8697	-0.3450	1.6900	-0.7000	0.1873	0.4000
1985	0.3328	0.8957	-0.3547	1.7200	-0.6522	0.2304	0.4915
1986	0.2915	0.7741	-0.3056	1.7481	-0.6980	0.1997	0.4254
1987	0.2916	0.7742	-0.3056	1.7482	-0.6981	0.1998	0.4250
At the Same means	0.21	0.56	-0.22	1.27	-0.78	0.16	0.31

1/ Estimates based on AIDS demand system with adding-up, homogeneity, and symmetry conditions imposed.

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